

WHAT IS CLAIMED IS:

1. A method for controlling blood flow through an extracorporeal blood circuit having a controller comprising the steps of:

a. withdrawing the blood from a withdrawal blood vessel in a patient into the extracorporeal circuit, treating the blood in the circuit, and infusing the treated blood into the patient;

b. detecting an occlusion which at least partially blocks the withdrawal or infusion of the blood;

c. in response to the detection of the occlusion, the controller automatically prompts the patient to move to alleviate the occlusion, and

d. in response to a prolonged occlusion, the controller issues an alarm.

2. A method for controlling blood flow as in claim 1 further comprising step (e) of automatically reducing a blood flow through the circuit in response to the detected occlusion.

3. A method for controlling blood flow as in claim 1 wherein step (c) further includes reducing a blood flow rate in response to the detection of the occlusion and the prompt of the patient follows the flow rate reduction.

4. A method for controlling blood flow as in claim 1 wherein step (c) includes reducing a flow rate of blood through the circuit and further comprising step (e) of increasing the flow rate of blood after detecting that the occlusion has been alleviated.

5. A method for controlling blood flow as in claim 1 wherein step (d) includes ceasing blood flow through the circuit.

6. A method for controlling blood flow as in claim 1 wherein the alarm in step (d) is issued at least after 30 seconds has elapsed since the occlusion is detected and the occlusion has not been alleviated.

7. A method for controlling blood flow as in claim 6 wherein the alarm is automatically terminated when the occlusion is alleviated.

8. A method for controlling blood flow as in claim 6 wherein the alarm is terminated after five minutes.

9. A method for controlling blood flow as in claim 1 wherein step (c) includes indicating to the patient to move a particular arm.

10. A method for controlling blood flow as in claim 1 wherein step (c) includes indicating whether the occlusion is in the withdrawal blood vessel or in an infusion blood vessel.

11. A method for controlling blood flow as in claim 1 wherein in step (c) the prompt to the patient is an audible response.

12. A method for controlling blood flow as in claim 1 wherein in step (c) the prompt to the patient is a synthetic voice prompt generated by the controller.

13. A method for controlling blood flow as in claim 1 wherein in step (c) the prompt to the patient is a visual response.

14. A method for controlling blood flow as in claim 1 wherein in step (c) the prompt to the patient is a text message generated on the screen display.

15. A method for controlling blood flow as in claim 1 wherein in step (c) the prompt to the patient is an icon generated on the screen display.

16. A method for controlling blood flow as in claim 1 further comprising step (e) of ceasing blood flow through the circuit if the prolonged occlusion continues for a predetermined period.

17. A method for controlling blood flow as in claim 1 wherein the blood circuit includes a blood filter, and further comprises step (e) of reducing a flow of filtrate from the filter in response to a reduction of blood flow through the filter and step (f) of increasing the flow of filtrate after the occlusion is alleviated.

18. A method for controlling blood flow as in claim 1 wherein the blood circuit includes a blood filter and further comprising step (e) of reducing a flow of filtrate from the filter in response to an increase of the suction pressure applied at a filtrate output of the filter, and step (f) of increasing the flow of filtrate after the suction pressure applied at a filtrate output decreases.

19. A method for controlling blood flow as in claim 1 wherein the blood circuit includes a blood filter, and further comprises step (e) of temporarily ceasing a flow of filtrate from the filter in response to a reduction of blood flow through the filter and step (f) of resuming the flow of filtrate after the occlusion is alleviated.

20. A method for controlling blood flow as in claim 1 wherein step (b) is performed by detecting a withdrawal pressure or infusion pressure crossing a predetermined threshold value.

21. A method for controlling blood flow as in claim 1 further comprising step (e) of detecting alleviation of the occlusion by sensing a pressure change in the withdrawal or infusion of the blood.

22. A method for controlling blood flow through an extracorporeal blood ultrafiltration circuit having a controller comprising the steps of:

a. selecting a desired filtration rate for the ultrafiltration circuit to extract filtrate for an ultrafiltration treatment;

b. withdrawing the blood from a withdrawal blood vessel in a patient into the extracorporeal circuit, filtering the blood to extract filtrates at the desired filtration rate, and infusing the filtered blood into the patient;

c. detecting a pressure of the blood being withdrawn or infused exceeding a predetermined threshold pressure value;

d. reducing a blood flow rate through the circuit in response to the detection of the pressure exceeding the threshold;

e. in connection with step (d), reducing a rate of filtrate extraction to a rate less than the desired filtration rate;

f. increasing the blood flow rate through the circuit after determining that the pressure of the blood being withdrawn or infused is within the threshold pressure value, and

g. increasing the filtration rate after step (f).

23. A method for controlling blood flow as in claim 22 wherein step (e) includes reducing the rate of filtrate extraction to substantially cease filtration.

24. A method for controlling blood flow as in claim 22 wherein step (e) includes reducing the rate of filtrate extraction proportionally to the reduction of blood flow rate through the circuit.

25. A method for controlling blood flow as in claim 22 further comprised step (h) of prompting the patient to move after step (c) and before step (f).

26. A method for controlling blood ultrafiltration of blood using an ultrafiltration blood circuit having a controller comprising the steps of:

a. withdrawing the blood from a withdrawal blood vessel in a patient into the extracorporeal circuit, filtering liquid ultrafiltrate from the

blood in the circuit containing a blood filter and infusing the filtered blood into the patient;

b. detecting an occlusion which at least partially blocks the withdrawal or infusion of the blood;

c. in response to the detection of the occlusion controller automatically reducing blood flow and reducing ultrafiltrate flow through the circuit;

d. detecting an alleviation of the occlusion, and

e. automatically increasing the blood flow and ultrafiltrate flow after the occlusion has been alleviated.

27. A method for controlling blood ultrafiltrate as in claim 26 further comprising the step (f) of prompting the patient to move to alleviate the occlusion.

28. A method for controlling blood ultrafiltration as in claim 26 wherein step (c) includes reducing a speed of a filtrate pump to reduce the ultrafiltrate flow.

29. A method for controlling blood ultrafiltration as in claim 26 wherein step (c) includes temporarily ceasing the ultrafiltrate flow.

30. A method for controlling blood ultrafiltration as in claim 26 wherein step (c) includes monitoring ultrafiltrate pressure between the filter and the ultrafiltrate pump.

31. A method for controlling ultrafiltration in a blood circuit having withdrawal and infusion blood passages connected to a patient, a filter, a blood pump, and a filtrate pump, said method comprising the steps:

a. withdrawing the blood from a withdrawal blood vessel in a patient into the blood circuit, filtering liquid ultrafiltrate from the blood in the filter, and infusing the filtered blood into the patient;

- b. controlling a flow ultrafiltrate from the filter to maintain an ultrafiltrate flow pressure above a predetermined pressure value;
- c. in response to a reduction of blood flow through the blood circuit, reducing the flow of ultrafiltrate to a flow.

32. A method for controlling ultrafiltration in a blood circuit as claim 31 wherein the blood circuit includes a filtrate pump controlling the flow of ultrafiltrate from the filter, and step (b) is performed by controlling a speed of the filtrate pump.

33. A method for controlling ultrafiltration in a blood circuit as claim 31 wherein step (c) is performed by temporarily ceasing the flow of ultrafiltrate.

34. A method for controlling ultrafiltration in a blood circuit as claim 31 wherein step (c) is performed by reducing the ultrafiltrate flow proportionally to the reduction of blood flow.

35. A method for controlling ultrafiltration in a blood circuit as claim 31 further comprising step (d) of issuing an alarm if the flow rate of ultrafiltration remains below a predetermined ultrafiltration flow rate for a prolonged period.

36. A method for controlling ultrafiltration in a blood circuit as claim 35 where the prolonged period is at least 5 minutes.

37. A method for controlling ultrafiltration in a blood circuit as claim 31 further comprising step (d) of issuing an alarm if the amount of ultrafiltrate obtained in a predetermined period is less than a predetermined amount.

38. A method for controlling ultrafiltration in a blood circuit as claim 37 wherein the predetermined period is 30 minutes.

2019-08-20